

WORLD EXHIBITIONS OF THE SECOND HALF OF THE 19th CENTURY: A MEANS OF UPDATING ENGINEERING AND HIGHLIGHTING ITS IMPORTANCE

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1.- World Exhibitions as a means of highlighting the economic, political and technological power of different countries.

The universality of industrial exhibitions in the second half of the 19th century added a new dimension to these events. Thus, the opportunities to compare the productive and technical capacities of different industries, hitherto limited to domestic exhibitions, were extended to the international ones.

London's Great Exhibition of 1851 focused attention on Britain's industrial might and demonstrated the superiority of British methods of mass production. The prevalent view that Britain should serve as a model for industrialisation in other countries¹ was challenged by the Paris Exhibition of 1855, which "corrected many of the false ideas that industry on the continent was subordinate to that of England"².

Held with regularity throughout the 19th century, World Exhibitions bore witness to industrial progress, at both national and international levels. In 1857, the engineer José Maria da Ponte e Horta said that when comparing "the two exhibitions at *Hyde Park* (1851) and *Champs-Élysées* (1855), from the standpoint of progress, we can conclude that all industries improved in terms of precision and development. Although the nations that took part in the Exhibition of 1851 were the undisputed masters of technology, other countries –the former disciples– had made enormous strides and promised, in the short-term, to match or even surpass their teachers. A comprehensive school, the exhibition set the standards of skills and demonstrated how far each

¹ BERGERON, Louis (1998) *Les industries de luxe en France*, Paris, Ed. Odile Jacob, 22.

² ACADEMIA DAS CIÊNCIAS DE LISBOA (1924) *Escritos d'El-Rei D. Pedro V*. Coligidos e publicados pela ..., Coimbra, ACL, 138/39.

country could advance on the road to industrial development defined at that time”³.

Thanks to the massive crowds drawn to the World Exhibitions, two goals were accomplished: competitiveness and publicity –deemed to be essential to the development of industry and the internationalisation of trade.

The exhibitions provided an opportunity for different countries to meet and draw comparisons. On the one hand, because of the festive atmosphere and the international cooperation needed for organisation, they helped to reduce political tension. At the time of the Paris Exhibition of 1878, which took place at the end of the Franco-Prussian War, Eça de Queirós wrote in London “since the inauguration of the Exhibition, and the recovery celebration in Paris, the whole of Europe has been calmer; a breeze of peace and reconciliation is blowing (...). The Exhibition seems to release a spirit of concord, labour and civilisation, fostering brotherhood and peace”⁴. On the other hand, they were “*un endroit autour duquel se cristallise la peur de l'autre*”⁵ because of the technical power exhibited, especially at the industrial and military levels. This rivalry between the various nations became exacerbated in the last quarter of the 19th century when the scramble for colonial markets increased the tension between the most industrialized countries in Europe.

Thus, the exhibitions contributed to the political and economic vitality of some countries, especially when the position of these countries on the world stage had been challenged. This was the case of France following its defeat after the Franco-Prussian War. Consequently, the Paris Exhibition of 1878 was regarded by the press as a great moral victory for France, a more splendid and enduring triumph than a military one. Two things were highlighted: first, within a few years France would be in a position to rejoin the battlefield and second, the productive capacity of France had undergone a considerable increase⁶. Nevertheless, the scientific and technological progress achieved by one country was not always an accurate reflection of the state of its econom-

3 HORTA, José Maria da Ponte e (1857) *Relatório sobre a Exposição Universal de Paris. Machinas de vapor. Parte I*, Lisboa, Imprensa Nacional, 26.

4 QUEIROZ, Eça de [1878] *Cartas de Inglaterra e Crónicas de Londres*, Lisboa, Ed. Livros do Brasil, 340.

5 MATTELART, Armand (1994) *L'invention de la communication*, Paris, Découverte, 148.

6 News published in newspapers such as *Tages Press*, *Nouvelle Presse Libre* e *Gazette d'Augsbourg*. Quoted by: LACROIX, E. [1878] *Études sur l'exposition de 1878. Annales et archives de l'industrie au XIXe siècle*, Paris, vol. 9, 90.

ic development nor did it necessarily mirror the general application of this progress. There were cases where countries produced machines or products exclusively for display at the exhibition.

Some exhibitions were associated with the commemoration of political events in order to legitimize a particular political regime. The French government's decision to hold a fair in 1889 to commemorate the centenary of the French Revolution was received with little enthusiasm in Europe and many countries declined to send an official delegation⁷. As Louis Figuier said:

“L'objection capital qu'on élevait en 1884 contre la réalisation de cette entreprise, c'était le refus que feraient certainement les grandes puissances européennes de participer à cette fête, destiné à glorifier les événements auxquels la France doit sa régénération politique. Prendre part à ce congrès industriel, à la date commémorative de 1789, c'était approuver l'émancipation des peuples et leurs révoltes contre le pouvoir des rois”⁸.

As the century progressed the recreational aspect of World Exhibitions grew in importance. This was much criticised at the time by those who felt that the excessive entertainment relegated the goals of the exhibitions to second place. The Paris Exhibition of 1900 confirmed that *“de plus en plus les expositions universelles perdent leur premier caractère et deviennent des entreprises de plaisir. L'intérêt de l'industrie et du commerce n'en est plus que le prétexte, l'amusement son but...”⁹.*

During the second half of the 19th century a number of international exhibitions were held; many of these were thematic, such as the electricity fair that was held in Paris in 1881. The distinction between World Exhibitions and international exhibitions was unclear. The Barcelona Fair of 1888, despite being called an international fair, is usually included among the World Exhibitions because of its impact and the number of exhibitors and visitors. The international electricity exhibitions held in Paris (1881), London and

⁷ Nonetheless, they recognised the importance of participating in the event and allowed the private sector to organise their delegations. In Portugal the Portuguese Industrial Association was entrusted with the task of representing the nation.

⁸ FIGUIER, Louis (1890) *L'Année Scientifique et Industrielle*, Paris, Librairie Hachette et Cie, 440.

⁹ GÉRAULT, G. (1902) *Les expositions universelles envisagées au point de vue de leurs résultats économiques*, Paris, Librairie Société Général des lois et des Arrêts, 22. Quoted by MATTE-LART (1994), 150.

Munich were important milestones in the spread of scientific progress and technological applications related to this source of energy.

2.- The Exhibition as a means of advancing scientific, technical and industrial progress.

The World Exhibitions, which allowed for the comparison of industrial, scientific and technological development of individual countries, offered a global view of the major problems that affected humanity and restricted industrial development. As Andrade Corvo pointed out in 1857 “after the Paris Exhibition (1855), this peaceful congress where nations sought to display their contributions to industry and modern art, and to provide a precise measure of their productive capacities, many important problems were highlighted, awaiting immediate solutions; today the attention of the men of science is mainly focused on the resolution of these problems; and if the year 1856 did not resolve all of them, it at least brought their resolution nearer”¹⁰.

The London Exhibition of 1851 was, according to Donald Cardwell, an important landmark in the history of technology and “the exhibition, in general, gives some impression of the ‘state of the art’ of the various technologies; for example, the magneto was classified as a mere toy”¹¹.

The exhibitions were ideal opportunities to spread knowledge of science and technology, particularly that with potential applications in industry to improve agricultural production or to provide new kinds of energy for transport. Initially it was steam power and then it was electricity that took pride of place at the exhibitions. In 1855, at a time when steam engines grew in importance for industry and transport, “the gallery set aside for steam engines was sumptuous”¹².

The exhibitions were often thought of as stages on which the latest scientific and technical developments were displayed. So for the layman they were the places to see new devices and technologies, which were likely to have most impact on daily life, whereas for scientists, technicians and industrialists they constituted “a vast and magnificent theatre of study and research”¹³.

¹⁰ *Annaes das Sciencias e das Artes* (1857), Lisboa, 33.

¹¹ CARDWELL, Donald (1994) *The Fontana History of Technology*, London, Fontana Press, 304, 285.

¹² HORTA (1857), 21.

¹³ HORTA, José Maria da Ponte e (1862) *Relatório sobre a Exposição Universal de Paris. Machinas de vapor e Motores hydraulicos*, Lisboa, Imprensa Nacional, 5.

By contributing to the emergence of a mass culture, the exhibitions played a decisive role in the way the public reacted to science and technology¹⁴.

Whenever a particular city organised a World Exhibition, it exploited the occasion to show off any urban improvement it had introduced. During the Paris Exhibition of 1867 visits were organised to the city sewers, and the pavilions at the Paris Exhibition of 1889 contained "*sur les 3.000 m² les progrès décisifs effectués depuis 1789 pour transformer Paris en capitale moderne: les égouts, l'eau, l'éclairage, les jardins publics, l'école pour tous, les marchés, les abattoirs, les mairies, les théâtres, les bibliothèques, la culture, l'hygiène et la science accessibles à tous, voilà ce qu'exprime le nouveau Paris*"¹⁵.

Because of the need to construct pavilions to house the different machines and products, the exhibitions drew attention to the development and use of new building techniques and materials. National, International and World Exhibitions were a pretext for erecting buildings in the style of iron architecture –the Crystal Palace–, which combined glass and iron. Some of these buildings were short-lived, such as the Palace built for the Paris Exhibition of 1867, whereas others were prefabricated with the result that they could be dismantled and re-assembled elsewhere, as was the case of Crystal Palace erected for London's Great Exhibition in 1851 and subsequently moved to Sydenham on the city's outskirts. The Eiffel Tower, which was built for the 1889 Exhibition and became a monumental symbol of the city, brought to the fore construction methods that Eiffel had already developed and applied to bridges and viaducts. The most striking feature of the Tower's construction was "*la bizarre inclination des immenses arceaux qui servent de base à la collunne monumental. Si vous demandez à un ingénieur, la raison d'être de ce mode spécial d'inclination et d'obliquité des courbes de la base, il vous dira que c'est par le calcul qu'on a été conduit à adopter cette courbe, et que nulle autre n'aurait été propre à supporter l'effort prodigieux du poids de métal que représente la dite masse*"¹⁶.

¹⁴ LAFUENTE, Antonio; SARAIVA, Tiago Figueiredo (1999) "Ciência, Técnica e Cultura de Massas". In MOURÃO, José Augusto; MATOS, Ana Maria Cardoso de; GUEDES, Maria Estela (ed.) *O Mundo Ibero-Americano nas Grandes Exposições*, Lisboa, Vega, 34.

¹⁵ BLANCOT, Christiane; LANDAU, Bernard (1994) "La direction des travaux de Paris au XIXe siècle". In BELHOSTE, Buno; MASSON, Francine; PICON, Antoine (dir.) *Le Paris des Polytechniciens. Des Ingénieurs dans la ville*, Paris, 173.

¹⁶ FIGUIER (1890), 462.

The Eiffel Tower of the 1889 Exhibition and the “*Halle des Machines*” (Engine Hall)¹⁷ played a major part in establishing the use of iron and steel in modern public works because they demonstrated their many building options. The engineers’ knowledge of new materials, mechanics and the resistance of materials could clearly be seen in the structures, which represented the triumph of iron architecture at this fair, and consequently re-affirmed the role of engineers.

Other building materials were also promoted at World Exhibitions. The 1878 Exhibition highlighted the increasing importance of Vicat and Portland cements in public works and the 1900 Exhibition established the use of concrete.

The exhibitions brought into existence a number of museums which promoted scientific, technical and industrial advances in each country and supported the teaching in technical centres. The Great Exhibition of 1851 gave rise to the first science museum. After the exhibitions, arts and trade institutions and technological and industrial museums requested some of the objects that had been on display, thereby contributing to the transfer and spread of technology.

World Exhibitions were a means of globalizing science and technology because they were events where the countries exhibited and publicised the advances they had made, and because the visitors passed on and reproduced the knowledge in their own countries. As Prince Napoleon said in 1855, “the problem for the future is how to share with the world that which hitherto has been the preserve of a few”¹⁸.

3.- Visits of engineers to the World Exhibitions in the 2nd half of the 19th century and the transfer of technology.

In order to learn about the scientific and technical developments in various sectors of the economy, Portuguese governments appointed committees to study the technological progress of other countries at the World Exhibitions. The engineers, who understood these advances in science and

¹⁷ This was the work of the French engineer V. Contamin with the collaboration of the architect Dutert.

¹⁸ *Diário do Governo*, núm. 102, 1861, 1163.

technology and the economic advantages for Portugal of the transfer and use of new machinery and manufacturing processes, and who were versed in the construction of buildings, roads and railways, made up the various study committees sent to these events. Often entrusted with making a specific study on a particular sector, such as hydraulic machines or steam engines, these engineers reported on the progress made in the fields of mechanics, hydraulics or chemistry in the countries represented at the fair, drawing parallels with the situation in Portugal.

The studies undertaken at any one time were determined by the need to develop sectors deemed to be of primary importance to the nation's development. Thus the committee sent to the Paris Exhibition of 1855 was entrusted with the task of studying "the state of progress in those industries that were of most benefit to Portugal"¹⁹, whereas the committee appointed to visit the London Exhibition of 1862 had to produce a report on "improvements in industrial mechanics, paying particular attention to engines, spinning mills and looms, rolling stock and the manufacture of carriages and means of transport for conventional roads"²⁰.

In the middle of the 19th century, industrial development policy based on Fontism (the economic doctrine introduced by Fontes Pereira de Melo) demanded a more systematic use of the steam engine with the result that attempts were made to implement the technological developments in other countries in regard to this energy source. To this end, the engineer José Maria da Ponte e Horta was entrusted with studying steam engines at the Paris Exhibition of 1855 and at the London Exhibition of 1862. As he stated in his report in 1855, "the association of the steam engine with the different operations, of which we find countless examples in industry today, is also an important aspect of the Exhibition". He went on to say that the steam engine became "such a familiar tool that engineers showed little fear when complying with the demands of modern industry"²¹. He argued therefore that Portugal would derive considerable benefit from the generalized use of steam engines.

The first railway was built in Portugal in 1852, at a time when the country lacked engineers with specialised training in the field. Moreover, the

¹⁹ MOPCI *Bulletin*, núm. 6, June 1857, 553.

²⁰ MENDES, J. Amado (1980) "Etapas e limites da industrialização", *O Século XIX em Portugal*, *Análise Social*, vol. XVI (61-61), 47.

²¹ HORTA (1857), 30-31.

Portuguese metallurgical and metalworking industries were stretched to construct the locomotives and other accessories to build railways. The Paris Exhibition of 1855 was an ideal opportunity to become acquainted with the progress other countries had made in this field and to purchase the necessary machinery and locomotives. To this end, the government entrusted the engineer, José Vitorino Damásio, with the task of studying locomotive systems and purchasing locomotives and carriages for the Eastern Line. The study of the development of the railway network entailed visits to the World Exhibitions in the following years. In 1878 one of the main issues concerning railroads was the building of narrow-gauge railways and the engineer, Cândido Celestino Xavier Cordeiro, was sent to study the subject at the Exhibition in Paris in the following year.

Given that Portugal is a country with a long coastline and a venerable naval tradition, the building and the revamping of ports and lighthouses also took on a great significance. And as in other fields this became the subject of study for a number of engineers who visited the exhibitions. For example the engineer, Adolfo Ferreira Loureiro, who was directly responsible for upgrading a number of Portuguese ports and who wrote an important book on the subject, was sent to study seaports at the Paris Exhibition of 1889.

The modernisation and mechanisation of agriculture became a major concern to successive governments given that Portugal was a country where a large part of the population was engaged in this sector and where agriculture accounted for a significant part of the gross national product. The introduction of agricultural machinery in Portugal demanded prior studies of the machines manufactured by more technologically advanced nations. To this end, the engineer Andrade Corvo was chosen to visit the Paris Exhibition of 1855. His study led to the publication of a report in which he set out "the method of construction, use, relative advantages, and usefulness of the most important machines making up the considerable agricultural collection at the 1855 Exhibition, with particular emphasis on those that could eventually be used in Portugal"²².

In addition to the engineers on the committees appointed to represent the nation or conduct thematic studies, a number of other engineers visited the

²² CORVO, João de Andrade (1857) *Relatório sobre a Exposição Universal de Paris. Agricultura*, Lisboa, Imprensa Nacional, 5.

World Exhibitions, independently or on behalf of municipalities or workers' associations. In 1855 Lisbon City Council sent the engineer, Joaquim Júlio Pereira de Carvalho, to the Paris Exhibition to study new inventions that could improve urban living. The mechanical engineer, Carlos Augusto Pinto Ferreira, a founder of the Centre to Promote Betterment among the Working Classes and a member of a number of industrial associations, was chosen by these organisations to attend the 1855 and 1862 Exhibitions. He was one of the engineers who, in 1889, accompanied a group of workers to the Paris Exhibition on behalf of Lisbon City Council.

In the second half of the 19th century, civil engineering training in Portugal was unable to produce enough engineers to meet the demand of industry and mining and public works. This situation was aggravated by the poor quality of their training in civil and industrial engineering. For these reasons, a number of Portuguese engineers completed, at the government's expense or at their own, their training abroad, in particular at the *École de Ponts et Chaussées* and at the *Grandes Écoles* in Paris. From the middle of the century the Ministry of Public Works, Trade and Industry awarded two State scholarships to the *École de Ponts et Chaussées* each year. Whenever exhibitions were held in Paris, the Portuguese government instructed those holding the scholarship at the time to study the technology exhibited. It was in this context that Cândido Celestino Xavier Cordeiro and Augusto Luciano Simões de Carvalho visited the Exhibition of 1867. The specific aim of Cordeiro was to study railway construction and track fixtures. The government intended in this way to broaden the education that the scholars received abroad.

World Exhibitions also had a direct bearing on the development of technical, scientific and industrial teaching in two ways. First, because many of the teachers at the institutions where the subjects were taught made trips to the exhibitions and then passed on the knowledge they had acquired to their students. Examples include Andrade Corvo, director and teacher at the Agricultural Institute, José Vitorino Damásio, director and teacher at the Lisbon Industrial Institute, as well as José Maria da Ponte e Horta and António Augusto de Aguiar, teachers at the Lisbon Polytechnic. Second, because they collected many artefacts for the industrial museums, institutions founded in association with the industrial schools.

In 1873 the engineer Joaquim Henriques Fradesso da Silveira was appointed royal commissioner to the Vienna Exhibition. As a result, he was able to acquire a considerable collection of the different products that had

been exhibited. The collection eventually formed part of the industry museum housed at Lisbon Customs and was later known as the *Fradesso da Silveira* museum. It closed down in 1877 and the exhibits were distributed among a number of state centres²³.

The visits to World Exhibitions by some of the engineers who later took up political or administrative posts in Portugal resulted in many of the measures taken to improve technical and industrial teaching and to modernise the national economy in technological terms. The trip made by António Augusto de Aguiar to the Paris Exhibition of 1878 resulted in the foundation of industrial and industrial design schools in different regional capitals a decade later.

The growing importance of the role of civil engineers at the World Exhibitions towards the end of the 19th century had far-reaching repercussions in Portugal. Perhaps that is why in 1900 the Portuguese Association of Civil Engineers organised a trip to the Paris Exhibition.

4.- The attempt to define international procedures in the field of engineering: conferences held in association with World Exhibitions.

A number of conferences on engineering matters were held in relation to World Exhibitions. In 1873, for example, the conference in Vienna on industrial property resulted in the first international convention on patents.

Many of these conferences played “*un rôle décisif, notamment dans la création de plusieurs institutions chargées de réguler les rapports internationaux en matière de communication*”²⁴. In 1878, at the Paris Exhibition, a conference reviewed the first Postal Union Treaty and re-affirmed its civilising mission. This conference had been preceded by a Telegraphic Conference held in Paris in 1865 on the initiative of Napoleon III. This gave rise to the Telegraphic Union, which according to Matellart was “*la première organisation internationale interéatique de l'ère moderne*”²⁵. José Vitorino Damásio was the Portuguese engineer chosen to represent his country at the meeting, probably because his name had already been considered for the post of director general of telegraphs, a position he took up in April of that year. While in office he standardised the Portuguese telegraph network.

²³ Ministerial Order issued by the Ministry of Public Works 14 September 1877.

²⁴ MATTELLART (1994), 144-145.

Since connecting Europe by rail was one of the main issues of the nineteenth century, a number of conferences on this theme were organised. Examples include the International Railways Conference held in Milan in 1887, where Portugal was represented by the engineer, Frederico Ressano Garcia. At the conference two years later the national representative was Manuel Afonso de Espergueira.

In 1895 the engineers, António José Antunes Navarro and Angelo Sarrea de Sousa Prado, took part in the International Railways Conference held in London. The former represented the government while the latter the Portuguese colonies.

In 1900, when the Portuguese Association of Civil Engineers organised a visit to the Paris Exhibition, a number of the engineers also attended the conferences held at the time. Bento Fortunato Almeida d'Eça, for example, was one of the engineers who attended the International Railways Conference held at the time.

5.- Conclusion.

The artefacts exhibited at World Exhibitions helped to increase the awareness of the role that engineers played in society. This enabled society to harness natural resources, encourage economic activities, upgrade buildings and urban areas, and to enjoy new household goods. All this contributed to the scientific and social recognition of the engineering profession.

The regularity with which the exhibitions were held meant that the scientific, technological and industrial advances made in the last fifty years of the nineteenth century could be assessed. The Paris Exhibition of 1900, which took as its theme a review of the century, set out to summarise the 19th century and to predict the 20th²⁶.

Throughout the second half of the 19th century, study visits to World Exhibitions helped Portuguese engineers to update their scientific and technological knowledge and to transfer it to Portugal.

²⁵ *Ibidem*, 146.

²⁶ MABIRE, Jean Christophe (dir.) (2000) *L'Exposition Universelle de 1900*, Paris, L'Harmattan, 20